EUROPEAN PATENT OFFICE

Patent Abstracts of Japan

PUBLICATION NUMBER : 09300178
PUBLICATION DATE : 25-11-97

APPLICATION DATE : 11-05-96
APPLICATION NUMBER : 08140648

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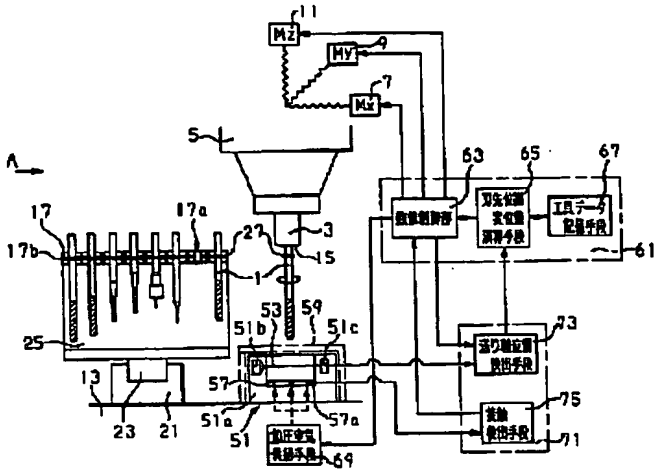
INT.CL. : B23Q 17/24 B23Q 15/22

TITLE : NC MACHINE TOOL PROVIDED WITH CUTTING EDGE TIP POSITION MEASURING FUNCTION OF TOOL



ABSTRACT : PROBLEM TO BE SOLVED: To perform the measurement of a cutting edge tip position of a tool which is rotated at rotary speed at the time of machining on an NC machine tool.

SOLUTION: When tool dimension is measured, a tool 1 is moved to a measurement region of a line sensor 51 on a table 13 while rotating the tool 1 at rotation speed at the time of machining. A cutting edge tip position displacement amount of the tool 1 is computed by a cutting edge tip position displacement amount computing means 65 based on a position of a feed shaft detected by a feed shaft position detection means 73 when a light receive section 51c detects blocking of light, actually measured tool data obtained from an output pattern of the line sensor 51, and tool data such as kind of tool, length, diameter, etc., of the tool which is stored in a tool data storage means 67, and it is sent to a numerical control section 63 of an NC machine tool as tool offset amount.

(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号

特開平9－300178

(43)公開日　平成９年(1997)11月25日

(51)Int.Cl.[6]	識別記号	庁内整理番号	ＦＩ		技術表示箇所
Ｂ２３Ｑ　17/24			Ｂ２３Ｑ　17/24		Ｂ
15/22			15/22		

審査請求　未請求　請求項の数５　ＦＤ　（全　８　頁）

(21)出願番号　特願平8－140648

(22)出願日　平成８年(1996)５月11日

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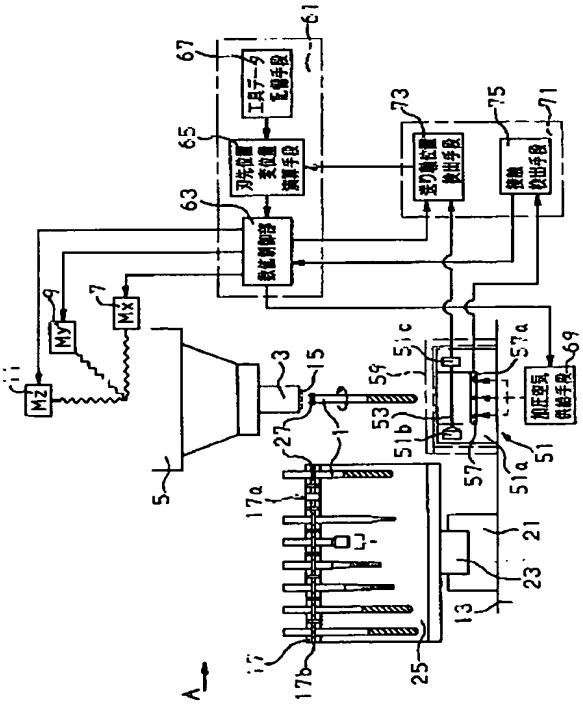
(54)【発明の名称】　工具の刃先位置測定機能を備えたＮＣ工作機械

(57)【要約】

【目的】　加工時の回転速度で回転している工具の刃先位置測定をＮＣ工作機械上で行える工具の刃先位置測定機能を備えたＮＣ工作機械を提供する。

【構成】　工具寸法測定時、工具１を加工時の回転速度で回転させながらテーブル１３上のラインセンサ５１の測定領域に移動させ、受光部５１ｃが遮光を検出したときに送り軸位置検出手段７３で検出された送り軸の位置およびラインセンサ５１の出力パターンから求めた実測工具データと、工具データ記憶手段６７に記憶された工具１の工具種類、長さ、直径等の工具データとから刃先位置変位量演算手段６５で当該工具１の刃先位置変位量を演算し、工具オフセット量としてＮＣ工作機械の数値制御部６３に送出するようにしたものである。



【特許請求の範囲】
【請求項１】　回転主軸に装着された工具とテーブルに載置されたワークとの間で数値制御部からの移動指令により送り軸を相対移動させて前記ワークを所望形状に加工するＮＣ工作機械において、
前記テーブルに設けられ互いに対向配置された投光部と複数個の受光素子を所定間隔に並べて構成された受光部とを有した光学式の刃先位置検出手段と、
前記工具を加工時の回転速度で回転させて前記刃先位置検出手段の前記投光部と受光部との間の測定領域に移動し、前記刃先位置検出手段が遮光を検出したときの前記送り軸の位置を検出する送り軸位置検出手段と、
前記工具の工具種類、長さ、直径等の工具データをあらかじめ記憶しておく工具データ記憶手段と、
前記送り軸位置検出手段で検出した前記送り軸の位置と前記工具データ記憶手段に記憶された工具データとから前記工具の刃先位置変位量を演算し、前記演算した結果を前記数値制御部に送出する刃先位置変位量演算手段と、
を具備したことを特徴とする工具の刃先位置測定機能を備えたＮＣ工作機械。
【請求項２】　回転主軸に装着された工具とテーブルに載置されたワークとの間で数値制御部からの移動指令により送り軸を相対移動させて前記ワークを所望形状に加工するＮＣ工作機械において、
前記テーブルに設けられ互いに対向配置された投光部と複数個の受光素子をマトリックス状に配列して構成された受光部とを有した光学式の刃先位置検出手段と、
前記工具を加工時の回転速度で回転させて前記刃先位置検出手段の前記投光部と受光部との間の測定領域に移動し、前記送り軸が所定位置に達したときの前記送り軸の位置を検出する送り軸位置検出手段と、
前記工具の工具種類、長さ、直径等の工具データをあらかじめ記憶しておく工具データ記憶手段と、
前記送り軸位置検出手段で検出した前記送り軸の位置および前記刃先位置検出手段の出力パターンから求めた実測工具データと、前記工具データ記憶手段に記憶された工具データとから前記工具の刃先位置変位量を演算し、前記演算した結果を前記数値制御部に送出する刃先位置変位量演算手段と、
を具備したことを特徴とする工具の刃先位置測定機能を備えたＮＣ工作機械。
【請求項３】　回転主軸に装着された工具とテーブルに載置されたワークとの間で数値制御部からの移動指令により送り軸を相対移動させて前記ワークを所望形状に加工するＮＣ工作機械において、
前記テーブルに設けられ互いに対向配置された投光部と複数個の受光素子を直線状に並べて構成された受光部とを有した光学式の刃先位置検出手段と、
前記工具を加工時の回転速度で回転させて前記刃先位置検出手段の前記投光部と受光部との間の測定領域に所定移動量ずつ移動させて行き、各所定位置で前記刃先位置検出手段が遮光を検出したときの前記送り軸の位置を検出する送り軸位置検出手段と、
前記工具の工具種類、長さ、直径等の工具データをあらかじめ記憶しておく工具データ記憶手段と、
前記各所定位置における前記送り軸位置検出手段で検出した前記送り軸の位置および前記刃先位置検出手段の出力パターンから求めた実測工具データと、前記工具データ記憶手段に記憶された工具データとから前記工具の刃先位置変位量を演算し、前記演算した結果を前記数値制御部に送出する刃先位置変位量演算手段と、
を具備したことを特徴とする工具の刃先位置測定機能を備えたＮＣ工作機械。
【請求項４】　前記刃先位置検出手段の測定領域に加圧空気を噴出する加圧空気噴出手段をさらに具備した請求項１から３のいずれか１項に記載の工具の刃先位置測定機能を備えたＮＣ工作機械。
【請求項５】　前記工具を前記刃先位置検出手段の測定領域に移動する時に前記工具と前記刃先位置検出手段との接触を検出して前記数値制御部に停止信号を送出する接触検出手段をさらに具備した請求項１から４のいずれか１項に記載の工具の刃先位置測定機能を備えたＮＣ工作機械。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明はＮＣフライス盤やマシニングセンタ等のＮＣ工作機械の主軸に装着された工具の刃先位置、特に加工時の回転速度で回転させたときの工具の刃先位置を非接触で測定する工具の刃先位置測定機能を備えたＮＣ工作機械に関する。
【０００２】
【従来の技術】近年、ＮＣフライス盤やマシニングセンタ等のＮＣ工作機械による加工の高速化および高精度化を実現するために、加工時の主軸の回転速度を高く設定する傾向にある。しかし、主軸の回転速度が高速になればなるほど主軸を回転させるモータの発熱による主軸の熱変位を引き起こしたり、主軸の回転により作用する遠心力で主軸に装着された工具が主軸内部に引き込まれる現象が発生して、主軸の回転中における工具長、工具径等の工具寸法変動および工具中心のずれを引き起こし主軸に装着された工具の刃先位置が変化してしまう。よって、加工時の回転速度での主軸回転時における工具長、工具径等の寸法変動および工具中心のずれを測定することにより工具の刃先位置変位量を演算し、この刃先位置変位量を考慮した上で加工を行わなければ加工の高精度化を実現することは難しい。
【０００３】一方、工具径寸法測定時に主軸に装着された工具を回転させずに工具刃先を接触式検出器の接触子に接触させ、あらかじめ定められた目標値と比較してそ

の差を工具径補正値として、ワークの加工寸法あるいは加工時の工具位置を工具径補正値だけ補正するようにした工具径補正装置を備えた数値制御工作機械がある（特公昭６１－５７１５１号公報参照）。また、主軸に装着された工具を切削時と逆方向に低速で回転させながら接触検出器の測定子に接触させ、基準位置から接触位置までの移動量に基づいて工具長および工具径等の工具寸法を自動的に測定、入力するようにした工作機械の工具寸法測定方法がある（特開平３－４３１３５号公報参照）。

【０００４】

【発明が解決しようとする課題】しかしながら、特公昭６１－５７１５１号公報に開示する工具径補正装置を備えた数値制御工作機械では、工具径寸法測定時に主軸に装着された工具を回転させず、静止状態のまま工具を接触式検出器の接触子に接触させることにより工具径補正値を求めるものであり、加工時の回転速度で主軸を回転させたときの工具径の寸法変動を測定するのではないために加工の高精度化は望めない。さらに、工具径寸法測定の度に主軸の回転を停止させていては加工時間がいたずらに長くなり加工効率が低下してしまう。また、特開平３－４３１３５号公報に開示する工作機械の工具寸法測定方法では、測定子が損傷しない低速回転数で切削時と逆方向に工具を回転させながら接触検出器の測定子に接触させることにより工具長および工具径等の寸法測定を行おうとするものであり、加工時の回転速度で主軸を回転させたときの工具の寸法測定を行う場合、たとえ工具を切削時と逆方向に回転させたとしても接触子が摩耗して検出精度が低下し故障の原因となる恐れがある。

【０００５】近年、微小径の工具を用いた微細な加工に対しても加工時の主軸回転速度を高くして加工の高速化および高精度化を図ろうとするＮＣ工作機械が出現している。しかし、微小径の工具の寸法測定時に上記に示したような測定子や接触子と工具との接触検出を利用した測定方法を採用した場合、微小径の工具の刃先が欠損したり、ダイヤモンド工具等の刃先材質によっては測定子や接触子に直接接触できないものもあり、このときには工具の寸法測定が不可能となってしまう。

【０００６】以上のような問題点を解決する技術として、工具回転用ユニットに装着されたボールエンドミルやドリル等の回転形工具を工具の軸線と直交方向に対向配置された投光部および受光部からなるラインセンサを備えた測定ヘッドの測定エリアに位置させ、工具を工具の軸線回りに所定角度回転して割り出しながら、工具移動手段により工具回転用ユニットを工具の軸線方向に往復移動させるとともに、測定ヘッド駆動手段により測定ヘッドの測定エリアの一端側を基準中心として工具の軸線と直交する軸線回りに所定角度回動させるようにして工具の寸法測定を行い、測定ヘッドのラインセンサからの測定値を制御・演算部に取り込み、工具先端の刃先回転面がつくる円の半径を演算する非接触式の回転形工具の測定装置がある（特公平４－６６２８６号公報参照）。しかしながら、特公平４－６６２８６号公報に開示する工具の測定装置はＮＣ工作機械本体とは別に設置されるものであり、ＮＣ工作機械の主軸に装着され加工時の回転速度で回転している工具の寸法測定を行うことは当然のことながら不可能である。また、この工具の測定装置をＮＣ工作機械上に設置して工具を回転させながら工具の寸法測定を行うと、加工終了後に工具に付着した切屑や加工液が測定ヘッドの測定エリアに飛散してラインセンサの投光部および受光部を汚してしまい測定精度に悪影響を及ぼしてしまう。

【０００７】そこで本発明は、加工時の回転数で回転させたときの工具の刃先位置測定をＮＣ工作機械上で行うことができる工具の刃先位置測定機能を備えたＮＣ工作機械を提供することを目的とする。また、本発明の他の目的は、上記工具の刃先位置測定を切屑等の付着の影響を無くし、かつ工具と刃先位置検出手段との接触の心配がない工具の刃先位置測定機能を備えたＮＣ工作機械を提供することである。さらに、本発明の他の目的は、工具の刃先位置変位量を演算してその演算結果をＮＣ工作機械の数値制御部に送出し、移動指令を補正して高精度な加工を行える工具の刃先位置測定機能を備えたＮＣ工作機械を提供することである。

【０００８】

【課題を解決するための手段】この目的に鑑み、本発明は以下に述べるとおりの各構成要件を具備してなる。

（１）回転主軸に装着された工具とテーブルに載置されたワークとの間で数値制御部からの移動指令により送り軸を相対移動させて前記ワークを所望形状に加工するＮＣ工作機械において、前記テーブルに設けられ互いに対向配置された投光部と複数個の受光素子を所定間隔に並べて構成された受光部とを有した光学式の刃先位置検出手段と、前記工具を加工時の回転速度で回転させて前記刃先位置検出手段の前記投光部と受光部との間の測定領域に移動し、前記刃先位置検出手段が遮光を検出したときの前記送り軸の位置を検出する送り軸位置検出手段と、前記工具の工具種類、長さ、直径等の工具データをあらかじめ記憶しておく工具データ記憶手段と、前記送り軸位置検出手段で検出した前記送り軸の位置と前記工具データ記憶手段に記憶された工具データとから前記工具の刃先位置変位量を演算し、前記演算した結果を前記数値制御部に送出する刃先位置変位量演算手段と、を具備した工具の刃先位置測定機能を備えたＮＣ工作機械。

【０００９】（２）回転主軸に装着された工具とテーブルに載置されたワークとの間で数値制御部からの移動指令により送り軸を相対移動させて前記ワークを所望形状に加工するＮＣ工作機械において、前記テーブルに設けられ互いに対向配置された投光部と複数個の受光素子をマトリックス状に配列して構成された受光部とを有した

光学式の刃先位置検出手段と、前記工具を加工時の回転速度で回転させて前記刃先位置検出手段の前記投光部と受光部との間の測定領域に移動し、前記送り軸が所定位置に達したときの前記送り軸の位置を検出する送り軸位置検出手段と、前記工具の工具種類、長さ、直径等の工具データをあらかじめ記憶しておく工具データ記憶手段と、前記送り軸位置検出手段で検出した前記送り軸の位置および前記刃先位置検出手段の出力パターンから求めた実測工具データと、前記工具データ記憶手段に記憶された工具データとから前記工具の刃先位置変位量を演算し、前記演算した結果を前記数値制御部に送出する刃先位置変位量演算手段と、を具備した工具の刃先位置測定機能を備えたＮＣ工作機械。

【００１０】（３）回転主軸に装着された工具とテーブルに載置されたワークとの間で数値制御部からの移動指令により送り軸を相対移動させて前記ワークを所望形状に加工するＮＣ工作機械において、前記テーブルに設けられ互いに対向配置された投光部と複数個の受光素子を直線状に並べて構成された受光部とを有した光学式の刃先位置検出手段と、前記工具を加工時の回転速度で回転させて前記刃先位置検出手段の前記投光部と受光部との間の測定領域に所定移動量ずつ移動させて行き、各所定位置で前記刃先位置検出手段が遮光を検出したときの前記送り軸の位置を検出する送り軸位置検出手段と、前記工具の工具種類、長さ、直径等の工具データをあらかじめ記憶しておく工具データ記憶手段と、前記各所定位置における前記送り軸位置検出手段で検出した前記送り軸の位置および前記刃先位置検出手段の出力パターンから求めた実測工具データと、前記工具データ記憶手段に記憶された工具データとから前記工具の刃先位置変位量を演算し、前記演算した結果を前記数値制御部に送出する刃先位置変位量演算手段と、を具備した工具の刃先位置測定機能を備えたＮＣ工作機械。

【００１１】（４）前記刃先位置検出手段の測定領域に加圧空気を噴出する加圧空気噴出手段をさらに具備した上記第（１）項から第（３）項のいずれか１項に記載の工具の刃先位置測定機能を備えたＮＣ工作機械。

（５）前記工具を前記刃先位置検出手段の測定領域に移動する時に前記工具と前記刃先位置検出手段との接触を検出して前記数値制御部に停止信号を送出する接触検出手段をさらに具備した上記（１）項から第（４）項のいずれか１項に記載の工具の刃先位置測定機能を備えたＮＣ工作機械。

【００１２】

【作用】上述の構成により、工具交換後等の工具寸法測定時、主軸に装着された工具を加工時の回転速度で回転させながらテーブルに設けられ互いに対向配置された投光部と複数個の受光素子を所定間隔に並べて構成した受光部とを有する光学式の刃先位置検出手段の測定領域に移動させる。刃先位置検出手段が遮光を検出したときに送り軸位置検出手段で検出した送り軸の位置および必要に応じて刃先位置検出手段の出力パターンから求めた実測工具データと、工具データ記憶手段に記憶された工具の工具種類、長さ、直径等の工具データとから刃先位置変位量演算手段で工具の刃先位置変位量を演算し、演算した刃先位置変位量をＮＣ工作機械の数値制御部に送出する。ＮＣ工作機械の数値制御部では、その刃先位置変位量と工具オフセット機能とを用いて移動指令の補正をしながら所望形状の加工を行う。よって、非接触式の刃先位置検出手段を採用して加工時の回転速度で回転している工具の寸法測定から工具オフセット量の演算までをＮＣ工作機械上で行うことができる。

【００１３】また、工具寸法測定時に刃先位置検出手段の測定領域に加圧空気噴出手段から加圧空気を噴出するようにしたので、工具が回転することにより切屑や加工液が測定領域に飛散したとしても刃先位置検出手段の投光部および受光部を汚すことがなく、かつ工具に付着した切屑等を除去できるので清潔な測定環境下で工具の刃先位置測定が行える。さらに、工具寸法測定時に工具が刃先位置検出手段の測定領域に移動する際に刃先位置検出手段に故障が発生したり誤動作が発生しても、工具と刃先位置検出手段との接触を接触検出手段が検出し、数値制御部に停止信号を送出するために工具や刃先位置検出手段の大きな損傷を防止することができる。

【００１４】

【発明の実施の形態】以下に、本発明の実施形態について図面に沿って説明する。図１は、本発明実施形態の工具の刃先位置測定機能を備えたＮＣ工作機械の要部側面図および構成ブロック図、図２は図１の矢視Ａによる正面図、図３はラインセンサの投光部および受光部を示す平面断面図、図４は工具の刃先位置測定時のマトリックスセンサを示す側面図である。

【００１５】まず、図１、図２を参照して本発明実施形態の工具の刃先位置測定機能を備えたＮＣ工作機械の要部を説明する。ＮＣ工作機械の本体（図示せず）は工具１を装着する主軸３が主軸頭５に回転自在に支持され、Ｘ軸送りモータ７、Ｙ軸送りモータ９、Ｚ軸送りモータ１１および主軸回転用モータ（図示せず）を駆動することにより、主軸頭５とワークを載置するテーブル１３とがＸ、Ｙ、Ｚ軸の直交３軸方向に相対移動するとともに主軸３が主軸頭５内で回転する。また、主軸３内部に設けられたドローバー（図示せず）下部に工具１を把持するコレットチャック１５が螺着され、主軸３内部をドローバーがコレットチャック１５とともに上下方向に移動可能となっている。よって、工具交換時に主軸３に装着された工具１をアンクランプ状態にして工具マガジン１７の工具ポット１７ａに収納するときは、ドローバーを下方に押し込むことによりコレットチャック１５を主軸３先端部から突出させコレットチャック１５を開放し、工具マガジン１７の工具ポット１７ａに収納されている

工具１を主軸３に装着するときは、ドローバーを引き上げてコレットチャック１５のテーパ部と主軸３先端部のテーパ穴とが嵌合してコレットチャック１５に把持力が与えられ工具１をクランプすることができる。

【００１６】テーブル１３側面に取り付けられたブラケット１９上にガイド２１が設けられ、ガイド２１によりＸ軸方向へ往復移動可能に案内されるキャリア２３上にマガジンベース２５が立設され、工具１を収納する工具マガジン１７がマガジンベース２５上に固定されている。工具マガジン１７は樹脂等の弾性材料からなる板材であり、左右方向に工具１を収納する８個の工具ポット１７ａが形成され、厚みの中間部に溝部１７ｂが形成された上下２層となっている。各工具１には弾性リング２７が嵌着され、工具マガジン１７の工具ポット１７ａへの収納時に工具マガジン１７に形成された溝部１７ｂと工具１に嵌着した弾性リング２７とが嵌まって軸線方向のおよその基準となり、弾性リング２７の上下を挟むようにして工具１が工具ポット１７ａに把持されている。

【００１７】キャリア２３左側面に取り付けられたプレート２９にはブラケット１９に設けられたシリンダ３１により進退するロッド３３が固定され、シリンダ３１にエアを供給してロッド３３を進退させることにより、キャリア２３上に立設したマガジンベース２５上に固定された工具マガジン１７を工具交換が可能である前進位置（図２を参照）とワークの加工領域外の退避位置との間でＸ軸方向に往復移動させることができる。プレート２９右側面にプーリ３５を回転自在に支持するプーリブラケット３７が取り付けられ、プーリ３５と同軸状に固着されたピニオン３９がガイド２１に取り付けられたラック４１と噛み合っている。プレート２９には加工中に切屑や加工液が工具マガジン１７周辺部に飛散することを防止するカバー４３が取り付けられ、カバー４３にはプーリ４５とともにマガジンカバー４７が同軸状に枢着されプーリ３５、４５との間にベルト４９が張設されている。

【００１８】通常、工具マガジン１７はワークの加工領域外である退避位置にありプレート２９に固定されたロッド３３が左行してマガジンカバー４７は閉じている。しかし、工具交換時はシリンダ３１にエアが供給されてプレート２９に固定されたロッド３３が右行し工具マガジン１７が前進し、ガイド２１に取り付けられたラック４１と噛み合っているピニオン３９に固定されたプーリ３５が反時計回りしてベルト４９を介しプーリ４５を反時計回りに回転させマガジンカバー４７が開く（図２を参照）。この状態で工具マガジン１７とＮＣ工作機械の主軸３との間でＸ、Ｙ、Ｚ軸の相対移動による自動工具交換、または工具マガジン１７に収納されている工具１の手動による差替えが可能となる。

【００１９】また、加工の妨げとならないテーブル１３上の所定位置には工具１の刃先位置を検出するラインセンサ５１が設けられている。図３に示すようにラインセンサ５１はテーブル１３上に取り付けられたセンサベース５１ａ内に、発光ダイオード等の光源からの光を平行光線５３へ変換するレンズを内蔵する投光部５１ｂと、投光部５１ｂから投光された光線５３を受光する複数の電荷結合型素子（ＣＣＤ）等の受光素子５５が所定間隔に配列された受光部５１ｃとが設けられ、投光部５１ｂと受光部５１ｃとは互いに対向するように配置されている。工具寸法測定時に工具１がラインセンサ５１の投光部５１ｂと受光部５１ｃとの間の測定領域に達し、投光部５１ｂから照射される光線５３を遮光したことを受光部５１ｃの受光素子５５で検出し電気信号に変換している。

【００２０】さらに、センサベース５１ａの測定領域入口部および底部にラインセンサ５１に故障が発生したり誤動作が発生したとき工具１との接触を検出する接触板５７が設けられている。底部の接触板５７には工具寸法測定時に工具１からラインセンサ５１の測定領域に飛散した切屑や加工液が投光部５１ｂおよび受光部５１ｃを汚さないようにするとともに、投光部５１ｂおよび受光部５１ｃの曇り止めの効果も発揮するようにラインセンサ５１の測定領域に向けて加圧空気を上方に噴出する複数個のノズル５７ａが配設されている。加圧空気は工具１に向けても噴出されるようになっており、工具寸法測定時に工具１の刃先等に付着した切屑等を測定領域外に吹き飛ばすことも可能である。ラインセンサ５１を取り囲むように設けられたセンサカバー５９は加工中に切屑や加工液がラインセンサ５１周辺部に飛散することを防止するものであり、工具寸法測定時にシリンダ（図示せず）にエアが供給され開きラインセンサ５１の測定領域を開放する。

【００２１】数値制御装置６１は数値制御部６３と刃先位置変位量演算手段６５と工具データ記憶手段６７とを具備している。数値制御部６３ではＮＣプログラムを読み取り、解読して直線補間や円弧補間の演算を行い、移動指令をサーボ部を通じてＸ軸送りモータ７、Ｙ軸送りモータ９、Ｚ軸送りモータ１１に送出して各軸送りモータの駆動制御を行うとともに、主軸回転用モータ（図示せず）に主軸３の回転指令を送出する。また、加工過程で工具交換指令が発せられたときには工具マガジン１７に移動指令を送出するとともに、ラインセンサ５１の測定領域へノズル５７ａからの加圧空気供給指令を加圧空気供給手段６９に送出する。

【００２２】工具データ記憶手段６７には工具マガジン１７に収納された工具１をツールプリセッタ等の計測器により計測した工具データをあらかじめ入力、記憶してある。この工具データは工具番号とともにボールエンドミル、スクエアエンドミル、フェイスエンドミル、ドリル等の工具種類と工具長、工具径等のデータである。刃先位置変位量演算手段６５は工具寸法測定時にラインセ

ンサ５１の光線５３が工具１により遮光されたことをラインセンサ５１で検出したときの送り軸の位置データと必要に応じてラインセンサ５１の出力パターンとから求めた実測工具データと、工具データ記憶手段６７から送出された工具データと、から工具１の刃先位置変位量である工具オフセット量を演算して数値制御部６３へ送出している。

【００２３】機械制御装置７１は送り軸位置検出手段７３と接触検出手段７５とを具備している。送り軸位置検出手段７３では数値制御装置６１内の数値制御部６３から各軸送りモータに送出される移動指令によりリニアスケールやロータリエンコーダ等を介してＸ、Ｙ、Ｚ軸の各送り軸の位置を刻々読み込んでいる。また、接触検出手段７５はラインセンサ５１に故障が発生したり誤動作が発生したときに、工具１とセンサベース５１ａの底部等に設けられた接触板５７との接触を検出して数値制御部６３に各軸送りモータの停止指令を送出する。

【００２４】ここから、本発明実施形態の工具の刃先位置測定機能を備えたＮＣ工作機械において、工具交換後に工具マガジンから主軸に装着された工具の工具長および工具径をラインセンサを用いて測定する動作制御の過程を説明する。

（１）所望形状の加工に用いる刃部形状の異なった複数種類の工具１に弾性リング２７を嵌着して工具マガジン１７の工具ポット１７ａに収納する。主軸３に工具１が装着されている場合は工具１を返却するための空の工具ポット１７ａを工具マガジン１７に設けておく（図１を参照）。

（２）加工過程で数値制御装置６１の数値制御部６３から工具交換指令が発せられると、数値制御部６３から機械制御装置７１に工具マガジン１７の移動指令が送出され、シリンダ３１にエアが供給されて工具マガジン１７が工具交換可能な位置まで前進するとともにマガジンカバー４７が開く。その後、工具マガジン１７とＮＣ工作機械の主軸３との間でＸ、Ｙ、Ｚ軸の相対移動により自動工具交換が行われる。

【００２５】（３）工具交換後に数値制御部６３から工具寸法測定指令が発せられると、数値制御部６３からの移動指令に基づいて工具１がラインセンサ５１上に位置決めされる。

（４）工具データ記憶手段６７から当該工具１の工具番号により工具種類、工具長、工具径等の工具データが刃先位置変位量演算手段６５に送出される。

（５）工具１を加工時の所望回転速度で回転させる。数値制御部６３から加圧空気供給手段６９に加圧空気供給指令が送出されラインセンサ５１の投光部５１ｂと受光部５１ｃとの間の測定領域に加圧空気が噴出されるとともに、センサカバー５９が開きラインセンサ５１の測定領域が開放状態となる。

（６）ラインセンサ５１の投光部５１ｂから受光部５１ｃに向けて光線５３が照射されラインセンサ５１上に位置決めされた工具１をＺ軸方向へ下降させる。

【００２６】（７）工具１によりラインセンサ５１の受光部５１ｃで光線５３を遮光した瞬間の出力が送り軸位置検出手段７３で検出されたら、その出力を検出した瞬間のＺ軸位置を数値制御部６３からＺ軸送りモータ１１に送出された移動指令より求める。ここで、ラインセンサ５１に故障が発生したり誤動作が発生したときには、工具１とセンサベース５１ａの底部等に設けられた接触板５７との接触を接触検出手段７５が検出し数値制御部６３にＺ軸送りモータ１１の停止指令を送出するために工具１やラインセンサ５１を破損することがなく安全である。

（８）求めたＺ軸位置と工具データ記憶手段６７に記憶された工具長データとから刃先位置変位量演算手段６５で工具長変位量を演算して、工具長オフセット量として数値制御部６３に送出し当該工具１におけるＮＣプログラムの移動量を補正しながら所望形状の加工が行われる。

【００２７】（９）さらに、工具径を測定したい場合には工具１をＺ軸方向へ下降させていき、工具径を測定したい位置に達した瞬間に工具１によりラインセンサ５１の受光部５１ｃで光線５３が遮光された出力パターンから遮光幅を求める。

（１０）求めたラインセンサ５１の受光部５１ｃにおける光線５３の遮光幅と工具データ記憶手段６７に記憶された工具径データとから刃先位置変位量演算手段６５で工具径変位量を演算して、工具径オフセット量として数値制御部６３に送出する。ここで、ラインセンサ５１の前方から光線５３に向けて工具１を移動させて行き光線５３を遮光した瞬間の工具１の位置と、ラインセンサ５１の後方から光線５３に向けて工具１を移動させて行き光線５３を遮光した瞬間の工具１の位置とから工具１の移動量を演算して、その移動量と光線５３の全幅との差から工具径を求めてもよい。

【００２８】次に、工具交換後に工具マガジンから主軸に装着された工具の刃先形状をラインセンサを用いて測定する動作制御を説明する。工具交換後に主軸３に装着された工具１をラインセンサ５１上に位置決めした後、加工時の回転速度で回転させながらＺ軸方向へ所定量ずつ下降させていき、送り軸位置検出手段７３で求めた各所定位置と各所定位置において工具１によりラインセンサ５１の受光部５１ｃで光線５３が遮光された出力パターンとから刃先位置変位量演算手段６５で実測工具データを演算する。演算した実測工具データと工具データ記憶手段６７に記憶された工具データとから刃先位置変位量演算手段６５で工具１の刃先位置変位量を演算して、工具長オフセット量および工具径オフセット量として数値制御部６３に送出する。また、工具データ記憶手段６７に工具１の許容変位量を記憶させておき、刃先位置変

位量演算手段６５で演算された刃先位置変位量と記憶された許容変位量とを比較した結果、記憶された許容変位量を越えている場合に当該工具１が摩耗していると判断し、数値制御部６３に予備工具交換指令を送出するようにしてもよい。

【００２９】さらに、図４にはラインセンサ５１における光線５３を縦方向にも所定間隔で並列に配設したマトリックスセンサ７７を示している。マトリックスセンサ７７はセンサベース７７ａに内蔵された投光部（図示せず）と受光部７７ｃとの間の測定領域にラインセンサ５１の測定領域と比べて幅を持たせたものである。マトリックスセンサ７７を用いた工具寸法測定の動作制御を説明する。工具交換後に工具マガジン１７から主軸３に装着された工具１をマトリックスセンサ７７上に位置決めした後で、加工時の回転速度で回転させながらＺ軸の所定位置へ下降させ、工具径および刃先形状を測定する個所をマトリックスセンサ７７の投光部と受光部７７ｃとの間の測定領域に位置させる。その位置において工具１によりマトリックスセンサ７７の受光部７７ｃで光線５３が遮光された出力パターンと送り軸位置検出手段７３で検出した位置とから当該工具１の工具径および刃先形状を求める。こうして求めた実測工具データと工具データ記憶手段６７に記憶された工具データとから刃先位置変位量演算手段６５で工具１の刃先位置変位量を演算して、工具長オフセット量または工具径オフセット量として数値制御部６３に送出する。よって、ボールエンドミルの先端球部の正確な刃先形状やあり溝フライスの刃部の正確な角度等が求められ、適切な補正を数値制御部６３に施して高精度の加工を行うことができる。なお、本実施形態で用いているラインセンサ５１やマトリックスセンサ７７の受光素子５５は数μｍ間隔で配列されており、ミクロンオーダの工具１の刃先位置測定が可能となっている。

【００３０】

【発明の効果】以上の説明から明らかなように、本発明によれば，工具交換後等の工具寸法測定時、主軸に装着された工具を加工時の回転速度で回転させながらテーブルに設けられ互いに対向配置された投光部と複数個の受光素子を所定間隔に並べて構成した受光部とを有する光学式の刃先位置検出手段の測定領域に移動させ、刃先位置検出手段が遮光を検出したときに送り軸位置検出手段で検出した送り軸の位置および必要に応じて刃先位置検出手段の出力パターンから求めた実測工具データと、工具データ記憶手段に記憶された工具の工具種類、長さ、直径等の工具データと、から刃先位置変位量演算手段で工具の刃先位置変位量を演算し、演算した刃先位置変位量をＮＣ工作機械の数値制御部に工具長オフセット量または工具径オフセット量として送出するようにした。よって、数値制御部ではこうしたオフセット量を用いて移動指令の補正をしながら所望形状の加工を行うので、高精度の加工を実現することができる。また、非接触式の刃先位置検出手段を採用しているため、加工時の回転速度で回転している工具の寸法測定から工具オフセット量の演算までをＮＣ工作機械上で正確に行え、加工の高速化および高精度化を図ることができる。微小径の工具の寸法測定時に刃先が欠損することもなく、刃先材質にも左右されないのであらゆる工具の寸法測定が可能になった。

【００３１】さらに、工具寸法測定時に刃先位置検出手段の測定領域に加圧空気噴出手段から加圧空気を噴出するようにしたので、工具が回転することにより切屑や加工液が測定領域に飛散したとしても刃先位置検出手段の投光部および受光部を汚すことがなくなり、かつ加圧空気は工具に向けても噴出されるため工具の刃先に付着した切屑や加工液を測定領域外に吹き飛ばすこともでき清潔な測定環境下で工具の刃先位置の測定を行うことができる。加えて、工具寸法測定時に工具が刃先位置検出手段の測定領域に移動する際に刃先位置検出手段に故障が発生したり誤動作が発生しても工具と刃先位置検出手段との接触を検出する接触検出手段からＮＣ工作機械の数値制御部に停止信号が送出されるので工具や刃先位置検出手段を大きく損傷させることもない。

【図面の簡単な説明】

【図１】本発明実施形態の工具の刃先位置測定機能を備えたＮＣ工作機械の要部側面図および構成ブロック図である。

【図２】図１の矢視Ａによる正面図である。

【図３】ラインセンサの投光部および受光部を示す平面断面図である。

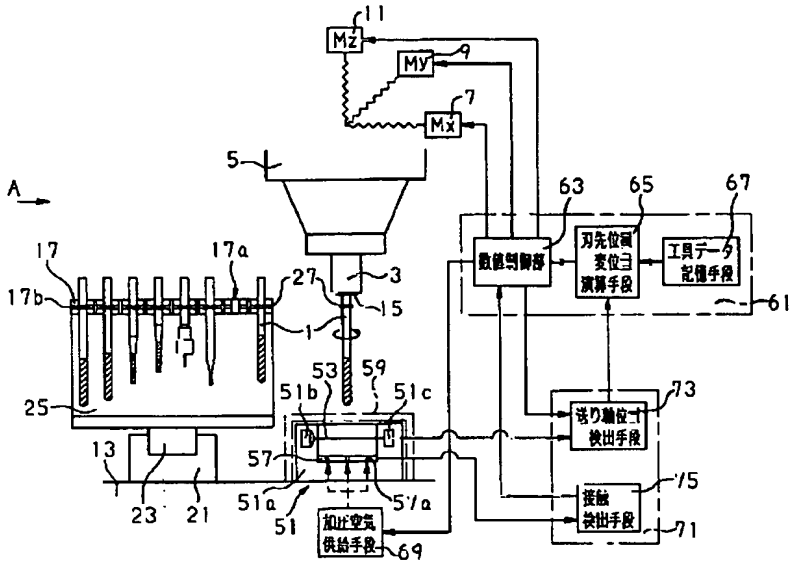
【図４】工具の刃先位置測定時のマトリックスセンサを示す側面図である。

【符号の説明】

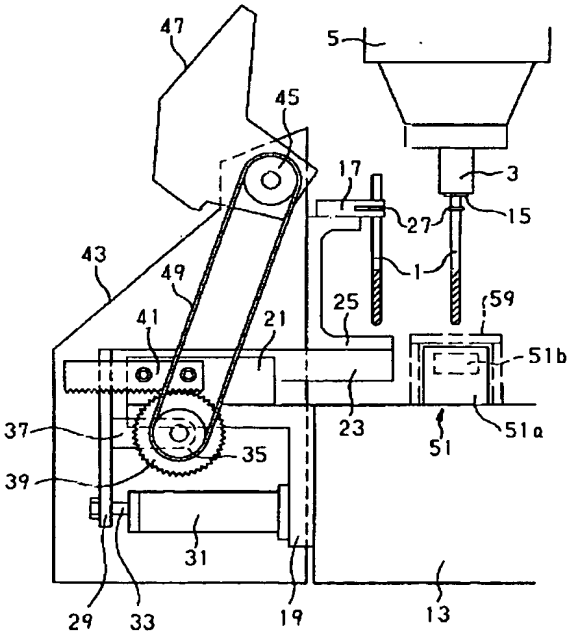
１　工具
３　主軸
５　主軸頭
１３　テーブル
５１　ラインセンサ
５１ａ　センサベース
５１ｂ　投光部
５１ｃ　受光部
５３　光線
５５　受光素子
５７　接触板
５７ａ　ノズル
６１　数値制御装置
６３　数値制御部
６５　刃先位置変位量演算手段
６７　工具データ記憶手段
６９　加圧空気供給手段
７１　機械制御装置

７３　送り軸位置検出手段
７５　接触検出手段
７７　マトリックスセンサ
７７ａ　センサベース
７７ｃ　受光部

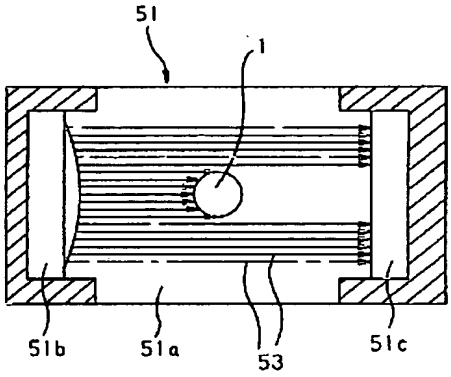
【図１】



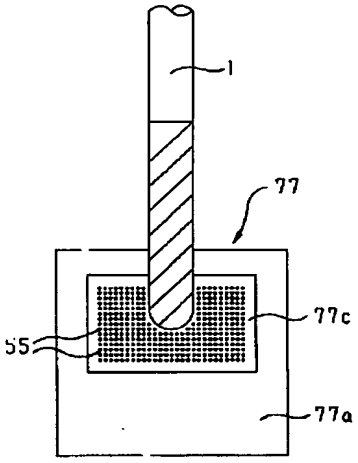
【図２】



【図３】



【図４】



DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the NC machine tool equipped with the edge-of-a-blade location measurement function of the tool which measures the edge-of-a-blade location of the tool at the time of making it rotate with the edge-of-a-blade location of the tool with which the main shaft of NC machine tools, such as NC milling machine and a machining center, was equipped, especially the rotational speed at the time of processing by non-contact.
[0002]
[Description of the Prior Art] In order to realize the improvement in the speed and highly-precise-izing of processing by NC machine tools, such as NC milling machine and a machining center, in recent years, it is in the inclination to set up highly the rotational speed of the main shaft at the time of processing. however, the heat of the main shaft by generation of heat of the motor which makes rotate a main shaft the more the more the rotational speed of a main shaft becomes a high speed -- will cause a variation rate, or the phenomenon in_which of the tool with which a main shaft was equipped with the centrifugal force which acts by rotation of a main shaft is drawn in the interior of a main shaft will occur, and the edge-of-a-blade location of the tool with which caused a gap of tool dimension fluctuation of the tool length under rotation of a main shaft, the diameter of a tool, etc. and a tool core, and a main shaft be equipped will change. therefore, the thing for which a gap of dimension fluctuation of the tool length at the time of the main shaft rotation with the rotational speed at the time of processing, the diameter of a tool, etc. and a tool core is measured -- the edge-of-a-blade location of a tool -- a variation rate -- an amount -- calculating -- this edge-of-a-blade location -- a variation rate -- if it is not processed after taking an amount into consideration, it is difficult to realize highly precise-ization of processing.
[0003] On the other hand, the tool edge of a blade is contacted to contact of a contact process detector, without rotating the tool with which the main shaft was equipped at the time of the diameter dimension measurement of a tool, and there is an NC machine tool equipped with the cutter compensation equipment with which only the cutter compensation value amended the processing dimension of a work piece or the tool location at the time of processing by making the difference into a cutter compensation value as compared with the desired value defined beforehand (refer to JP,61-57151,B). Moreover, the gauge head of a contact detector is made to contact, making the time of cutting, and hard flow rotate the tool with which the main shaft was equipped at a low speed, it is based on the movement magnitude from a criteria location to a contact location, and there is a tool dimension measuring method of the machine tool which measures automatically tool dimensions, such as tool length and a diameter of a tool, and inputted them (refer to JP,3-43135,A).

[0004]
[Problem(s) to be Solved by the Invention] However, in the NC machine tool equipped with the cutter-compensation equipment indicated to JP,61-57151,B, the tool with which the main shaft was equipped at the time of the diameter dimension measurement of a tool is not rotated, a cutter-compensation value is calculated by contacting a tool to contact of a contact process detector with a quiescent state, and in order not to measure dimension fluctuation of the diameter of a tool when rotating a main shaft with the rotational speed at the time of processing, highly precise-ization of processing cannot be desired. Furthermore, if rotation of a main shaft is stopped at every diameter dimension measurement of a tool, floor to floor time will become long in vain, and processing effectiveness will fall. moreover, by the tool dimension measuring method of the machine tool indicated to JP,3-43135,A It is what is going to perform dimension measurement of tool length, the diameter of a tool, etc. by making the gauge head of a contact detector contact, making the time of cutting, and hard flow rotate a tool by the reduced rpm which a gauge head does not damage. When performing dimension measurement of the tool when rotating a main shaft with the rotational speed at the time of processing, even if it makes the time of cutting, and hard flow rotate a tool even if, there is a possibility of wearing contact out, and detection precision falling and becoming the cause of failure.
[0005] In recent years, the NC machine tool which is going to make high main shaft rotational speed at the time of processing also to detailed processing using the tool of the diameter of minute, and is going to attain improvement in the speed and highly-precise-izing of processing has appeared. However, when the measuring method using contact detection with a gauge head, contact, and a tool as shown above at the time of dimension measurement of the tool of the diameter of minute is adopted, the edge of a blade of the tool of the diameter of minute suffers a loss, or some which cannot carry out direct contact depending on the edge-of-a-blade quality of the materials, such as a diamond tool, are in a gauge head or contact, and dimension measuring [of a tool] will become impossible at this time.
[0006] You make it located in the measurement area of the measuring head equipped with the line sensor which consists of the floodlighting section and the light sensing portion by which opposite arrangement was carried out in the axis and the rectangular direction of a tool in rotation form tools with which the unit for tool rotation was equipped, such as a ball end mill and a drill, as a technique which solves the above troubles. While making the both-way migration of the unit for tool rotation carry out in the direction of an axis of a tool with a tool migration means, carrying out predetermined include-angle rotation and deducing a tool to the circumference of the axis of a tool By the measuring head driving means, by setting the end side of the measurement area of a measuring head as a criteria core, as predetermined include-angle rotation is carried out, dimension measurement of a tool is performed to the circumference of the axis of a tool, and the axis which intersects perpendicularly. the measured value from the line sensor of a measuring head -- control and operation part -- incorporating -- the edge of a blade at the tip of a tool -- there is a measuring device of the non-contact-type rotation form tool which calculates the radius of a circle which surface of revolution builds (refer to JP,4-66286,B). However, the measuring device of the tool indicated to JP,4-66286,B is impossible for performing dimension measurement of the tool which an NC machine tool body is independently installed, and the main shaft of an NC machine tool is equipped with it, and it is rotating with the rotational speed at the time of processing with a natural thing. Moreover, if dimension measurement of a tool is performed installing the measuring device of this tool on an NC machine tool, and rotating a tool, the swarf and working liquid which adhered to the tool after processing termination will disperse in the measurement area of a measuring head, will soil the floodlighting section and the light

sensing portion of a line sensor, and will have a bad influence on the accuracy of measurement.
[0007] Then, this invention aims at offering the NC machine tool equipped with the edge-of-a-blade location measurement function of a tool which can perform edge-of-a-blade location measurement of the tool at the time of making it rotate at the rotational frequency at the time of processing on an NC machine tool. Moreover, other purposes of this invention are offering the NC machine tool equipped with the edge-of-a-blade location measurement function of the tool which loses the effect of adhesion by edge-of-a-blade location measurement of the above-mentioned tool, such as swarf, and does not have worries about contact for a tool and an edge-of-a-blade location detection means. furthermore, other purposes of this invention -- the edge-of-a-blade location of a tool -- a variation rate -- it is offering the NC machine tool equipped with the edge-of-a-blade location measurement function of a tool which calculates an amount, sends out the result of an operation to the numerical-control section of an NC machine tool, amends a migration command, and can perform highly precise processing.
[0008]
[Means for Solving the Problem] In view of this purpose, this invention comes to provide each requirement for a configuration as stated below.
(1) In the NC machine tool which a feed shaft is made displaced relatively by the migration command from the numerical-control section between the tool with which the rotation main shaft was equipped, and the work piece laid in the table, and processes said work piece into a request configuration An optical edge-of-a-blade location detection means with the light sensing portion constituted by arranging in predetermined spacing the floodlighting section by which was prepared in said table and opposite arrangement was carried out mutually, and two or more photo detectors, A feed shaft location detection means to detect the location of said feed shaft when said tool is rotated with the rotational speed at the time of processing, it moves to the measurement field between said floodlighting sections and light sensing portions of said edge-of-a-blade location detection means and said edge-of-a-blade location detection means detects protection from light, A tool data storage means to memorize beforehand tool data, such as a tool class of said tool, die length, and a diameter, the edge-of-a-blade location of the tool data memorized by the location and said tool data storage means of said feed shaft detected with said feed shaft location detection means to said tool -- a variation rate -- the edge-of-a-blade location which calculates an amount and sends out said calculated result to said numerical-control section -- a variation rate -- with an amount operation means The NC machine tool equipped with the edge-of-a-blade location measurement function of the tool provided.
[0009] (2) In the NC machine tool which a feed shaft is made displaced relatively by the migration command from the numerical-control section between the tool with which the rotation main shaft was equipped, and the work piece laid in the table, and processes said work piece into a request configuration An optical edge-of-a-blade location detection means with the light sensing portion constituted by arranging the floodlighting section by which was prepared in said table and opposite arrangement was carried out mutually, and two or more photo detectors in the shape of a matrix, A feed shaft location detection means to detect the location of said feed shaft when said tool is rotated with the rotational speed at the time of processing, it moves to the measurement field between said floodlighting sections and light sensing portions of said edge-of-a-blade location detection means and said feed shaft arrives at a predetermined location, A tool data storage means to memorize beforehand tool data, such as a tool class of said tool, die length, and a diameter, The observation tool data for which it asked from the location of said feed shaft detected with said feed shaft location detection means, and the output pattern of said edge-of-a-blade location detection means, the edge-of-a-blade

location of the tool data memorized by said tool data storage means to said tool -- a variation rate -- the edge-of-a-blade location which calculates an amount and sends out said calculated result to said numerical-control section -- a variation rate -- the NC machine tool equipped with the edge-of-a-blade location measurement function possessing an amount operation means of a tool.
[0010] (3) In the NC machine tool which a feed shaft is made displaced relatively by the migration command from the numerical-control section between the tool with which the rotation main shaft was equipped, and the work piece laid in the table, and processes said work piece into a request configuration An optical edge-of-a-blade location detection means with the light sensing portion constituted by arranging the floodlighting section by which was prepared in said table and opposite arrangement was carried out mutually, and two or more photo detectors in the shape of a straight line, Rotate said tool with the rotational speed at the time of processing, and make it move to the measurement field between said floodlighting sections and light sensing portions of said edge-of-a-blade location detection means predetermined movement magnitude every, and it goes to it. A feed shaft location detection means to detect the location of said feed shaft when said edge-of-a-blade location detection means detects protection from light in an orientation everywhere, A tool data storage means to memorize beforehand tool data, such as a tool class of said tool, die length, and a diameter, The observation tool data for which it asked from the location of said feed shaft detected with said feed shaft location detection means in an orientation everywhere [said], and the output pattern of said edge-of-a-blade location detection means, the edge-of-a-blade location of the tool data memorized by said tool data storage means to said tool -- a variation rate -- the edge-of-a-blade location which calculates an amount and sends out said calculated result to said numerical-control section -- a variation rate -- the NC machine tool equipped with the edge-of-a-blade location measurement function possessing an amount operation means of a tool.
[0011] (4) The NC machine tool which equipped with the edge-of-a-blade location measurement function of the tool of a publication any 1 term of a ****** (1) term to the ** (3) term which possesses further a pressurization air jet means to spout pressurization air to the measurement field of said edge-of-a-blade location detection means.
(5) said -- a tool -- said -- the edge of a blade -- a location -- detection -- a means -- measurement -- a field -- moving -- the time -- said -- a tool -- said -- the edge of a blade -- a location -- detection -- a means -- contact -- detecting -- said -- numerical control -- the section -- a stop signal -- sending out -- contact -- detection -- a means -- further -- having provided -- the above -- (-- one --) -- a term -- from -- ** -- (-- four --) -- a term -- some -- one -- a term -- a publication -- a tool -- the edge of a blade -- a location -- a measurement function -- having had -- an NC machine tool -- .
[0012]
[Function] It is made to move to the measurement field of an optical edge-of-a-blade location detection means to have the light sensing portion which put in order and constituted the floodlighting section by which was prepared in the table and opposite arrangement was mutually carried out while rotating the tool with which the main shaft was equipped with the rotational speed at the time of processing at the time of the tool dimension measurement after tool exchange etc. , and two or more photo detectors at predetermined spacing by the above-mentioned configuration . The observation tool data for which it asked from the output pattern of an edge-of-a-blade location detection means if needed [the location and if needed] for a feed shaft which were detected with the feed shaft location detection means when an edge-of-a-blade location detection means detected protection from light, the edge-of-a-blade location from tool data, such as a tool class of tool memorized by the tool data storage means, die length, and a diameter, -- a variation rate -- an amount operation means -- the edge-of-a-blade

location of a tool -- a variation rate -- the edge-of-a-blade location which calculated and calculated the amount -- a variation rate -- an amount is sent out to the numerical-control section of an NC machine tool. the numerical-control section of an NC machine tool -- the edge-of-a-blade location -- a variation rate -- a request configuration is processed, amending a migration command using an amount and a tool-offset function. Therefore, from dimension measurement of the tool which adopts the edge-of-a-blade location detection means of a non-contact type, and is rotating with the rotational speed at the time of processing to the operation of the amount of tool offsets can be performed on an NC machine tool.

[0013] Moreover, since the swarf which did not soil the floodlighting section and the light sensing portion of an edge-of-a-blade location detection means, and adhered to a tool is removable even if swarf and working liquid disperse to a measurement field when a tool rotates since it made spout pressurization air from a pressurization air jet means to the measurement field of an edge-of-a-blade location detection means at the time of tool dimension measurement, edge-of-a-blade location measurement of a tool can perform under a clean measurement environment. Furthermore, in case a tool moves to the measurement field of an edge-of-a-blade location detection means at the time of tool dimension measurement, even if failure occurs for an edge-of-a-blade location detection means or malfunction occurs, a contact detection means detects contact for a tool and an edge-of-a-blade location detection means, and since a stop signal is sent out to the numerical-control section, the big damage on a tool or an edge-of-a-blade location detection means can prevent.

[0014]

[Embodiment of the Invention] Below, the operation gestalt of this invention is explained along with a drawing. The important section side elevation of an NC machine tool where drawing 1 was equipped with the edge-of-a-blade location measurement function of the tool of this invention operation gestalt and a configuration block Fig., the front view according [drawing 2] to the view A of drawing 1 , the flat-surface sectional view in which drawing 3 shows the floodlighting section and the light sensing portion of a line sensor, and drawing 4 are the side elevations showing the matrix sensor at the time of edge-of-a-blade location measurement of a tool.

[0015] First, the important section of the NC machine tool equipped with the edge-of-a-blade location measurement function of the tool of this invention operation gestalt with reference to drawing 1 and drawing 2 is explained. The main shaft 3 equipped with a tool 1 is supported by the spindle head 5 free [rotation], and by driving the X-axis delivery motor 7, the Y-axis delivery motor 9, the Z-axis delivery motor 11, and the motor for main shaft rotation (not shown), a main shaft 3 rotates the body (not shown) of an NC machine tool within a spindle head 5 while a spindle head 5 and the table 13 which lays a work piece are displaced relatively to X, Y, and rectangular cross 3 shaft orientations of the Z-axis. Moreover, the collet chuck 15 which grasps a tool 1 is screwed on the draw bar (not shown) lower part prepared in the main shaft 3 interior, and a draw bar is [interior / main shaft 3] movable in the vertical direction in a collet chuck 15. Therefore, when changing into an unclamping condition the tool 1 with which the main shaft 3 was equipped at the time of tool exchange and containing to tool pot 17a of a tool magazine 17 By pushing in a draw bar caudad, make a collet chuck 15 project from main shaft 3 point, and a collet chuck 15 is opened wide. When equipping a main shaft 3 with the tool 1 contained by tool pot 17a of a tool magazine 17 A draw bar is pulled up, the tapered bore of the taper section of a collet chuck 15 and main shaft 3 point fits in, a retention span is given to a collet chuck 15, and a tool 1 can be clamped.

[0016] A guide 21 is formed on the bracket 19 attached in table 13 side face, the magazine base 25 is set up with a guide 21 to X shaft orientations at the both-way carrier 23 top guided movable, and the tool magazine 17 which contains a tool 1 is being fixed

on the magazine base 25. A tool magazine 17 is a plate which consists of spring materials, such as resin, and serves as the vertical two-layer one by which eight tool pot 17a which contains a tool 1 to a longitudinal direction was formed, and slot 17b was formed in the pars intermedia of thickness. The tool 1 is grasped by tool pot 17a, as the elastic ring 27 is attached in each tool 1, and slot 17b formed in the tool magazine 17 at the time of the receipt to tool pot 17a of a tool magazine 17 and the elastic ring 27 attached in the tool 1 fit in, it becomes the near criteria of the direction of an axis and the upper and lower sides of the elastic ring 27 are inserted.

[0017] By fixing the rod 33 which moves in the cylinder 31 prepared in the bracket 19 to the plate 29 attached in carrier 23 left lateral, supplying air to a cylinder 31, and making a rod 33 move X shaft orientations can be made to carry out both-way migration of the tool magazine 17 fixed on the magazine base 25 set up on the carrier 23 between the advance location (to see drawing 2) in which tool exchange is possible, and the evacuation location outside the processing field of a work piece. The pulley bracket 37 supported for a pulley 35 to plate 29 right lateral, enabling free rotation was attached, and the pulley 35 and the pinion 39 which fixed in the shape of the same axle have geared with the rack 41 attached in the guide 21. The covering 43 which prevents that swarf and working liquid disperse during processing at tool-magazine 17 periphery is attached in a plate 29, the magazine covering 47 is pivoted by covering 43 in the shape of the same axle with a pulley 45, and the belt 49 is stretched among pulleys 35 and 45.

[0018] Usually, the rod 33 which is in the evacuation location which is outside the processing field of a work piece, and was fixed to the plate 29 went leftward, and the tool magazine 17 has closed the magazine covering 47. However, the rod 33 which air was supplied to the cylinder 31 and fixed to the plate 29 goes rightward, a tool magazine 17 moves forward, and the pulley 35 fixed to the pinion 39 which has geared with the rack 41 attached in the guide 21 carries out the counterclockwise rotation of the time of tool exchange, it rotates a pulley 45 counterclockwise through a belt 49, and the magazine covering 47 opens it (see drawing 2). X, Y, the automatic tool exchange by relative displacement of the Z-axis, or substitution by the hand control of the tool 1 contained by the tool magazine 17 is attained between a tool magazine 17 and the main shaft 3 of an NC machine tool in this condition.

[0019] Moreover, the line sensor 51 which detects the edge-of-a-blade location of a tool 1 is formed in the predetermined location on the table 13 used as the hindrance of processing. Floodlighting section 51b which builds in the lens which changes the light from the light source of light emitting diode etc. into a parallel ray 53 in sensor base 51a by which the line sensor 51 was attached on the table 13 as shown in drawing 3 , Light sensing portion 51c by which the photo detectors 55, such as two or more charge coupling mold components (CCD) which receive the beam of light 53 floodlighted from floodlighting section 51b, were arranged by predetermined spacing is prepared, and floodlighting section 51b and light sensing portion 51c are arranged so that it may counter mutually. It detected having shaded the beam of light 53 which a tool 1 arrives at the measurement field between floodlighting section 51b of a line sensor 51, and light sensing portion 51c, and is irradiated from floodlighting section 51b at the time of tool dimension measurement by the photo detector 55 of light sensing portion 51c, and has changed into the electrical signal.

[0020] Furthermore, when failure occurs at the measurement field inlet-port section and the pars basilaris ossis occipitalis of sensor base 51a or malfunction occurs in a line sensor 51 at them, the contact bowl 57 which detects contact in a tool 1 is formed. While making it the swarf or working liquid which dispersed from the tool 1 to the measurement field of a line sensor 51 at the time of tool dimension measurement not soil floodlighting section 51b and light sensing portion 51c to the contact bowl 57 of a pars basilaris ossis occipitalis, two or more nozzle 57a which spouts pressurization air up

towards the measurement field of a line sensor 51 so that the effectiveness of the cloudy stop of floodlighting section 51b and light sensing portion 51c may also be demonstrated is arranged. Pressurization air can also blow away the swarf which blew off even if turned to the tool 1, and adhered to the edge of a blade of a tool 1 etc. at the time of tool dimension measurement out of a measurement field. It prevents that swarf and working liquid disperse during processing at line sensor 51 periphery, air is supplied to a cylinder (not shown) at the time of tool dimension measurement, and the sensor covering 59 prepared so that a line sensor 51 might be surrounded opens the measurement field of the aperture line sensor 51.

[0021] numerical-control equipment 61 -- the numerical-control section 63 and an edge-of-a-blade location -- a variation rate -- the amount operation means 65 and the tool data storage means 67 are provided. In the numerical-control section 63, while NC program is read and decoded and performing the operation of linear interpolation or circular interpolation, sending out a migration command to the X-axis delivery motor 7, the Y-axis delivery motor 9, and the Z-axis delivery motor 11 through the servo section and performing drive control of each axial delivery motor, the rotation command of a main shaft 3 is sent out to the motor for main shaft rotation (not shown). Moreover, when a tool exchange command is emitted in a processing process, while sending out a migration command to a tool magazine 17, the pressurization air supply command from nozzle 57a is sent out to the pressurization air supply means 69 to the measurement field of a line sensor 51.

[0022] For the tool data storage means 67, the tool data which measured the tool 1 contained by the tool magazine 17 with instrumentations, such as a tool presetter, are inputted and memorized beforehand. This tool data is data, such as tool classes, such as a ball end mill, a square end mill, a face end mill, and a drill, tool length, and a diameter of a tool, in a tool number. an edge-of-a-blade location -- a variation rate -- the tool data with which an amount operation means 65 was sent out at the time of tool dimension measurement from the observation tool data with which the beam of light 53 of a line sensor 51 asked for having been shaded by the tool 1 from the output pattern of a line sensor 51 if needed [when a line sensor 51 detects / location data and if needed] for a feed shaft, and a tool data-storage means 67 -- since -- the edge-of-a-blade location of a tool 1 -- a variation rate -- the amount of tool offsets which is an amount calculated, and it has sent out to the numerical-control section 63.

[0023] Machine control equipment 71 possesses the feed shaft location detection means 73 and the contact detection means 75. With the feed shaft location detection means 73, the location of each feed shaft of X, Y, and the Z-axis is read from the numerical-control section 63 in numerical-control equipment 61 every moment through the linear scale, the rotary encoder, etc. by the migration command sent out to each axial delivery motor. Moreover, when failure occurs in a line sensor 51 or malfunction occurs, the contact detection means 75 detects contact to a tool 1 and the contact bowl 57 formed in the pars basilaris ossis occipitalis of sensor base 51a etc., and sends out the halt command of each axial delivery motor to the numerical-control section 63.

[0024] The process of the motion control which measures from here the tool length and the diameter of a tool of the tool with which the main shaft was equipped from the tool magazine after tool exchange using a line sensor in the NC machine tool equipped with the edge-of-a-blade location measurement function of the tool of this invention operation gestalt is explained.

(1) Attach the elastic ring 27 in two or more kinds of tools 1 by which the cutting part configurations used for processing of a request configuration differed, and contain to tool pot 17a of a tool magazine 17. When the main shaft 3 is equipped with the tool 1, tool pot 17a of the empty for returning a tool 1 is prepared in the tool magazine 17 (see drawing 1).

(2) if a tool exchange command is emitted from the numerical-control section 63 of numerical-control equipment 61 in a processing process, the migration command of a tool magazine 17 will be sent out to machine control equipment 71 from the numerical-control section 63, and air will supply a cylinder 31 -- having -- a tool magazine 17 -- a tool -- while moving forward to an exchangeable location, the magazine covering 47 opens. Then, automatic tool exchange is performed by relative displacement of X, Y, and the Z-axis between a tool magazine 17 and the main shaft 3 of an NC machine tool.
[0025] (3) If a tool dimension measurement command is emitted from the numerical-control section 63 after tool exchange, based on the migration command from the numerical-control section 63, a tool 1 will be positioned on a line sensor 51.
(4) the tool number of the tool data storage means 67 to the tool 1 concerned -- tool data, such as a tool class, tool length, and a diameter of a tool, -- an edge-of-a-blade location -- a variation rate -- it is sent out to the amount operation means 65.
(5) Rotate a tool 1 with the request rotational speed at the time of processing. While a pressurization air supply command is sent out to the pressurization air supply means 69 from the numerical-control section 63 and pressurization air blows off to the measurement field between floodlighting section 51b of a line sensor 51, and light sensing portion 51c, the sensor covering 59 opens and the measurement field of a line sensor 51 will be in an open condition.
(6) Drop the tool 1 which the beam of light 53 was irradiated towards floodlighting section 51b to light sensing portion 51c of a line sensor 51, and was positioned on the line sensor 51 to Z shaft orientations.
[0026] (7) If the output of the moment of shading a beam of light 53 by light sensing portion 51c of a line sensor 51 by the tool 1 is detected by the feed shaft location detection means 73, it will ask for the Z-axis location of the moment of detecting the output, from the migration command sent out to the Z-axis delivery motor 11 from the numerical-control section 63. When failure occurs in a line sensor 51 or malfunction occurs here, since the contact detection means 75 detects contact to a tool 1 and the contact bowl 57 formed in the pars basilaris ossis occipitalis of sensor base 51a etc. and the halt command of the Z-axis delivery motor 11 is sent out to the numerical-control section 63, it damages neither a tool 1 nor a line sensor 51 and is safe.
(8) the edge-of-a-blade location from the tool length data memorized by the Z-axis location for which it asked, and the tool data storage means 67 -- a variation rate -- the amount operation means 65 -- tool length -- a variation rate -- an amount is calculated, and processing of a request configuration is performed, sending out to the numerical-control section 63 as an amount of tool length offsets, and amending the movement magnitude of NC program in the tool 1 concerned.
[0027] (9) A tool 1 is further dropped to Z shaft orientations to measure the diameter of a tool, and it asks for protection-from-light width of face from the output pattern by which the beam of light 53 was shaded by light sensing portion 51c of a line sensor 51 by the tool 1 at the moment of arriving at the location which wants to measure the diameter of a tool.
(10) the edge-of-a-blade location from the diameter data of a tool memorized by the protection-from-light width of face and the tool data storage means 67 of a beam of light 53 in light sensing portion 51c of the line sensor 51 for which it asked -- a variation rate -- the amount operation means 65 -- the diameter of a tool -- a variation rate -- calculate an amount and send out to the numerical-control section 63 as an amount of tool radius offsets. Here, the movement magnitude of a tool 1 may be calculated from the location of the tool 1 of the moment of having moved the tool 1 towards the beam of light 53 from the location of the tool 1 of the moment of having moved the tool 1 towards the beam of light 53 from the front of a line sensor 51, having gone, and shading a beam of light 53, and the back of a line sensor 51, having gone, and shading a beam of light 53,

and you may ask for the diameter of a tool from a difference movement magnitude and full [of a beam of light 53]. [the]
[0028] Next, the motion control which measures the edge-of-a-blade configuration of the tool with which the main shaft was equipped using a line sensor from a tool magazine after tool exchange is explained. After positioning the tool 1 with which the main shaft 3 was equipped after tool exchange on a line sensor 51, It is made to descend to Z shaft orientations the specified quantity every, making it rotate with the rotational speed at the time of processing. the edge-of-a-blade location from the output pattern by which the beam of light 53 was shaded everywhere for which it asked with the feed shaft location detection means 73 by light sensing portion 51c of a line sensor 51 by the tool 1 in the orientation an orientation and everywhere -- a variation rate -- observation tool data are calculated with the amount operation means 65. the edge-of-a-blade location from the tool data memorized by the calculated observation tool data and the tool data storage means 67 -- a variation rate -- the amount operation means 65 -- the edge-of-a-blade location of a tool 1 -- a variation rate -- an amount is calculated and it sends out to the numerical-control section 63 as the amount of tool length offsets, and an amount of tool radius offsets. The amount is made to memorize. moreover, the tool data storage means 67 -- permission of a tool 1 -- a variation rate -- an edge-of-a-blade location -- a variation rate -- the edge-of-a-blade location calculated with the amount operation means 65 -- a variation rate -- the permission remembered to be an amount -- a variation rate -- the permission memorized as a result of measuring an amount -- a variation rate -- when it is over the amount, it judges that the tool 1 concerned is worn out, and you may make it send out a reserve tool exchange command to the numerical-control section 63
[0029] Furthermore, the matrix sensor 77 which arranged the beam of light 53 in a line sensor 51 also in the lengthwise direction at intervals of predetermined at juxtaposition is shown in drawing 4 . The matrix sensor 77 gives width of face to the measurement field between the floodlighting sections (not shown) and light sensing portion 77c which were built in sensor base 77a compared with the measurement field of a line sensor 51. The motion control of the tool dimension measurement using the matrix sensor 77 is explained. After positioning the tool 1 with which the main shaft 3 was equipped from the tool magazine 17 after tool exchange on the matrix sensor 77, it is made to descend to the predetermined location of the Z-axis, making it rotate with the rotational speed at the time of processing, and the part which measures the diameter of a tool and an edge-of-a-blade configuration is located in the measurement field between the floodlighting section of the matrix sensor 77, and light sensing portion 77c. The diameter of a tool and edge-of-a-blade configuration of the tool 1 concerned are searched for from the output pattern by which the beam of light 53 was shaded by light sensing portion 77c of the matrix sensor 77 by the tool 1 in the location, and the location detected with the feed shaft location detection means 73. in this way, the edge-of-a-blade location from the tool data memorized by the observation tool data for which it asked, and the tool data storage means 67 -- a variation rate -- the amount operation means 65 -- the edge-of-a-blade location of a tool 1 -- a variation rate -- an amount is calculated and it sends out to the numerical-control section 63 as the amount of tool length offsets, or an amount of tool radius offsets. therefore, an edge-of-a-blade configuration with the exact tip bulb of a ball end mill -- it is, an include angle with the exact cutting part of a slotting milling cutter etc. can be called for, suitable amendment can be performed to the numerical-control section 63, and highly precise processing can be performed. In addition, the photo detector 55 of the line sensor 51 used with this operation gestalt or the matrix sensor 77 is arranged at intervals of several micrometers, and edge-of-a-blade location measurement of the tool 1 of micron order is possible for it.
[0030]
[Effect of the Invention] According to this invention, so that clearly from the above

explanation At the time of the tool dimension measurement after tool exchange etc. It is made to move to the measurement field of an optical edge-of-a-blade location detection means to have the light sensing portion which put in order and constituted the floodlighting section by which was prepared in the table and opposite arrangement was mutually carried out while rotating the tool with which the main shaft was equipped with the rotational speed at the time of processing, and two or more photo detectors at predetermined spacing. The observation tool data for which it asked from the output pattern of an edge-of-a-blade location detection means if needed [the location and if needed] for a feed shaft which were detected with the feed shaft location detection means when an edge-of-a-blade location detection means detected protection from light, Tool data, such as a tool class of tool memorized by the tool data storage means, die length, and a diameter, since -- an edge-of-a-blade location -- a variation rate -- an amount operation means -- the edge-of-a-blade location of a tool -- a variation rate -- the edge-of-a-blade location which calculated and calculated the amount -- a variation rate -- the amount was sent out to the numerical-control section of an NC machine tool as the amount of tool length offsets, or an amount of tool radius offsets. Therefore, since a request configuration is processed amending a migration command using such an amount of offset in the numerical-control section, highly precise processing is realizable. Moreover, since the edge-of-a-blade location detection means of a non-contact type is adopted, from dimension measurement of the tool which is rotating with the rotational speed at the time of processing to the operation of the amount of tool offsets can be correctly performed on an NC machine tool, and improvement in the speed and highly-precise-izing of processing can be attained. Without the edge of a blade suffering a loss at the time of dimension measurement of the tool of the diameter of minute, since it was not influenced by the edge-of-a-blade quality of the material, either, dimension measurement of all tools was attained.

[0031] Furthermore, since it was made to spout pressurization air from a pressurization air jet means to the measurement field of an edge-of-a-blade location detection means at the time of tool dimension measurement Soiling the floodlighting section and the light sensing portion of an edge-of-a-blade location detection means, even if swarf and working liquid disperse to a measurement field, when a tool rotates is lost. And since pressurization air blows off even if it turns it to a tool, it can also blow away the swarf and working liquid adhering to the edge of a blade of a tool out of a measurement field, and can measure the edge-of-a-blade location of a tool under a clean measurement environment. In addition, since a stop signal is sent out to the numerical-control section of an NC machine tool from a contact detection means detect contact for a tool and an edge-of-a-blade location detection means even if failure occurs for an edge-of-a-blade location detection means or malfunction occurs, in case a tool moves to the measurement field of an edge-of-a-blade location detection means at the time of tool dimension measurement, neither a tool nor an edge-of-a-blade location detection means do not damage greatly.

[Translation done.]

CLAIMS

[Claim(s)]
[Claim 1] In the NC machine tool which a feed shaft is made displaced relatively by the migration command from the numerical-control section between the tool with which the rotation main shaft was equipped, and the work piece laid in the table, and processes said work piece into a request configuration An optical edge-of-a-blade location detection means with the light sensing portion constituted by arranging in predetermined spacing the floodlighting section by which was prepared in said table and opposite arrangement was carried out mutually, and two or more photo detectors, A feed shaft location detection means to detect the location of said feed shaft when said tool is rotated with the rotational speed at the time of processing, it moves to the measurement field between said floodlighting sections and light sensing portions of said edge-of-a-blade location detection means and said edge-of-a-blade location detection means detects protection from light, A tool data storage means to memorize beforehand tool data, such as a tool class of said tool, die length, and a diameter, the edge-of-a-blade location of the tool data memorized by the location and said tool data storage means of said feed shaft detected with said feed shaft location detection means to said tool -- a variation rate -- the edge-of-a-blade location which calculates an amount and sends out said calculated result to said numerical-control section -- a variation rate -- with an amount operation means The NC machine tool equipped with the edge-of-a-blade location measurement function of the tool characterized by providing.
[Claim 2] In the NC machine tool which a feed shaft is made displaced relatively by the migration command from the numerical-control section between the tool with which the rotation main shaft was equipped, and the work piece laid in the table, and processes said work piece into a request configuration An optical edge-of-a-blade location detection means with the light sensing portion constituted by arranging the floodlighting section by which was prepared in said table and opposite arrangement was carried out mutually, and two or more photo detectors in the shape of a matrix, A feed shaft location detection means to detect the location of said feed shaft when said tool is rotated with the rotational speed at the time of processing, it moves to the measurement field between said floodlighting sections and light sensing portions of said edge-of-a-blade location detection means and said feed shaft arrives at a predetermined location, A tool data storage means to memorize beforehand tool data, such as a tool class of said tool, die length, and a diameter, The observation tool data for which it asked from the location of said feed shaft detected with said feed shaft location detection means, and the output pattern of said edge-of-a-blade location detection means, the edge-of-a-blade location of the tool data memorized by said tool data storage means to said tool -- a variation rate -- the edge-of-a-blade location which calculates an amount and sends out said calculated result to said numerical-control section -- a variation rate -- the NC machine tool equipped with the edge-of-a-blade location measurement function of the tool characterized by providing an amount operation means.

[Claim 3] In the NC machine tool which a feed shaft is made displaced relatively by the migration command from the numerical-control section between the tool with which the rotation main shaft was equipped, and the work piece laid in the table, and processes said work piece into a request configuration An optical edge-of-a-blade location detection means with the light sensing portion constituted by arranging the floodlighting section by which was prepared in said table and opposite arrangement was carried out mutually, and two or more photo detectors in the shape of a straight line, Rotate said tool with the rotational speed at the time of processing, and make it move to the measurement field between said floodlighting sections and light sensing portions of said edge-of-a-blade location detection means predetermined movement magnitude every, and it goes to it. A feed shaft location detection means to detect the location of said feed shaft when said edge-of-a-blade location detection means detects protection from light in an orientation everywhere, A tool data storage means to memorize beforehand tool data, such as a tool class of said tool, die length, and a diameter, The observation tool data for which it asked from the location of said feed shaft detected with said feed shaft location detection means in an orientation everywhere [said], and the output pattern of said edge-of-a-blade location detection means, the edge-of-a-blade location of the tool data memorized by said tool data storage means to said tool -- a variation rate -- the edge-of-a-blade location which calculates an amount and sends out said calculated result to said numerical-control section -- a variation rate -- the NC machine tool equipped with the edge-of-a-blade location measurement function of the tool characterized by providing an amount operation means.

[Claim 4] The NC machine tool which equipped with the edge-of-a-blade location measurement function of the tool of a publication any 1 term of claims 1-3 which possess further a pressurization air jet means to spout pressurization air to the measurement field of said edge-of-a-blade location detection means.

[Claim 5] The NC machine tool which equipped with the edge-of-a-blade location measurement function of the tool of a publication any 1 term of claims 1-4 which possess further a contact detection means to detect contact for said tool and said edge-of-a-blade location detection means, and to send out a stop signal to said numerical-control section when moving said tool to the measurement field of said edge-of-a-blade location detection means.

[Translation done.]